4-22-2020

Atmospheric Effects on Small Plant Life

James Hole
Fort Hays State University, jmhole@mail.fhsu.edu

Paul Adams
Fort Hays State University, peadams@fhsu.edu

Atmospheric Effects on Small Plant Life

James Hole, Dr. Paul Adams, Mackinzie Foster
Fort Hays State University

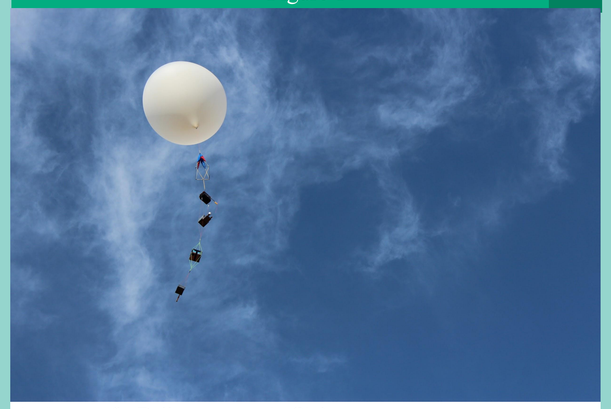
Abstract

The upper atmosphere has drastically different conditions when compared to the surface of the earth, with heightened radiation and lowered pressures. These atmospheric conditions can mimic conditions on other planets, namely Mars. An experiment was performed to determine how relatively brief exposure(s) to these conditions would affect the growth of *Brassica rapa*, or mustard seed plants.
When compared to other plants of the same species, but exposed to different conditions, the plants that had been fully exposed to the upper atmosphere had similar, but slightly worse growths than the other plant specimens.

Introduction

By exposing the seeds of plant life to the upper atmosphere, the growth of a plant can be altering in such a way that it benefits the growth of the plant. By observing how exposure to different conditions affects plant life and growth, knowledge of how those conditions affects plant life can be gleaned. This knowledge can be used in certain scenarios, such as possibly improving the yield of crops by sending seeds to become exposed to the upper atmospheric conditions, or to determine how plant life may grow on different planets. The experiment described in this poster is performed to determine the result of the hypothesis; If plant seeds experience higher radiation and different pressure, then those plant will grow smaller proportional to however much radiation and pressure that they experience.

Figure 1



A picture of a Balloon set-up in flight.

Methods

To start the experiment, the necessary supplies were all procured, including Mustard plants seeds, Tomato seeds, fresh Potatoes, chemical heating packs, lead foil, and small sealable containers, as well as the rest of the materials for a standard High Altitude Balloon launch, including insulating foam, braided cord, a telemetry kit, a parachute, key ring, Helium, and a weather balloon.
Before flight, package each sample, with at least 30 seeds per sample, so as to control different variables; seeds in containers will be placed in a portion of a flight box wrapped in lead to control for radiation. The containers can be sealed so that the pressure shall remain unchanged. There will also be seeds exposed to both radiation and pressure as well as neither. Finally, during the flight process, a fourth set of seeds will be maintained on the ground, to act as a control group. (See Figure 1 for a picture of a flight set up) After the flight, each sample will be prepared and grown accordingly, preferably under a Bio Lab.
Each seed sample will be planted in a separate container, with the specific type of container not mattering so much as ensuring that all of the containers are uniform and have the necessary space to grow several small plants at the same time. The same type of soil will be used for each seed set, as with the same amount of water and sunlight. (See Figure 2 for an example) 6 seeds from each set will be planted per flight. The rest of the seeds will be flown again for further testing. The previous step will be repeated after each flight, with 6 seeds taken out from each sample and planted, until there have been seeds which have experienced 5 flights. Maintenance will occur twice a week, including shifting and watering the plants.
The plants will be measured on a weekly basis after planting, with the measurements including height, number of leaves, number of sprouts, the color of the plant, whether any mutations occur, and if the plants grow at all. All measured results will be compiled and compared with each other.

Results

The results for this experiment consist of the number of plants that grew from the six seeds planted, the average number of leaves per plant in each batch, and the average height of the plant. See Figure 3 for the measurements.
Due to unforeseen circumstances, some of the plants were not able to be measured in a timely manner, so parts of the results had to be extrapolated based on other data measurements before and after, which has affected the results.

Figure 2

A picture of the first set of Plants.

Figure 3

	# of Plants	Avg # of Leaves	Avg Height (cm)		# of Plants	Avg # of Leaves	Avg Height (cm)
C1W1	2	2	2.2	C2W1	4	2	2
R1W1	4	2	2.4	R2W1	2	2	2.1
P1W1	1	2	1.8	P2W1	4	2	2.1
F1W1	0	0	0	F2W1	2	2	2
C1W2	2	3	3.9	C2W2	4	2	2
R1W2	4	4	4.9	R2W2	3	2	2
P1W2	1	2	3.7	P2W2	4	2	4
F1W2	0	0	0	F2W2	2	2	2
C1W3	2	5	6.9	C2W3	3	3	3
R1W3	4	6	8.9	R2W3	3	3	3
P1W3	1	5	6	P2W3	4	2	5
F1W3	4	2	1.9	F2W3	2	2	3
C1W4	2	6	7.6	C2W4	3	3	3
R1W4	4	8	9.2	R2W4	3	3	3.4
P1W4	1	5	6.3	P2W4	4	3	6.6
F1W4	4	2	3.4	F2W4	2	2	3

A graph, created using Microsoft Excel, with the measured and extrapolated values of the Number of Plants, the Average number of Leaves, and the Average height of the plants per batch.

Discussion

Looking at the data in Figure 3, there is a difference between the fully exposed plants when compared to the other plant batches when. The height of the fully exposed plants is slightly above half of the next shortest plant, and the plants did not have a noticeable growth for the first two weeks as opposed to the other plants amongst the other batches, which all grew above the soil height in a noticeable and measurable fashion within the first week. While the fully exposed plants did grow smaller and slower than the other plants, the first sample to be exposed to radiation grew significantly larger than the other plants, ending up over 1.5 cm taller than all of the other plants, including in other batches. This is repeated in the next batch of plants, where the pressure exposed plant grew noticeably taller than the rest of the plants. These samples also had the largest number of leaves within their respective batches. Of all the experiments, despite the extrapolations that occurred in order to produce comparable results, the plants exposed to only radiation grew the largest, while the fully exposed grew the smallest.

Conclusions

The fully exposed seeds grew the smallest, giving validity to the previous hypothesis. However, the radiation exposed plants grew larger than the control plants, meaning that the hypothesis is only partially true. This could have different meanings, such as only the combinations of higher radiation and lower pressure is detrimental to plant growth, while only higher radiation is beneficial. It could also mean that there was some discrepancy between the seed groups. Due to the aforementioned circumstances, these results are somewhat inaccurate, which would mean that further or repeated testing would be necessary to verify the results. If this experiment is repeated, and similar results are found, then plant growth briefly exposure to higher atmospheric conditions, much less long exposure, would yield smaller, less healthy plants than otherwise. This would mean that any areas with similar atmospheres, such as Mars, would have less potential to yield plants with average growths, if at all. However, if further testing shows differing results, such as fully exposed plants growing larger in a more healthy fashion than control plants, then plant growths on Mars could bear some fruit, and there could even be practical applications on Earth involving exposing plants to small amounts of radiation in order to increase crop yields. In either case, more research into the matter is warranted.

References

Special thanks to
Dr. Brian R. Maricle, Ph.D.
Ann Noble
Gigi Launchbach
Mikyung Jang and Haeun Kim